

LADYZHENSKIY, M., inzhener-kapitan 3-go ranga

Training apparatus in rocket units. Voen. vest. 41 no.5:
120-122 My '61. (MIRA 14:8)
(Rockets (Ordnance))--Study and teaching)

1971-1972, 1973, 1974.

Currenters logical elements in ship automation. Rech. transp.
1971-1972, 1973, 1974. (MIRA 18:8)

AUTHOR

LADYSHENSKIY, M.D.

PA - 2204

TITLE

Damping of Shock Waves (Zatukhaniye udarnykh voln).

PERIODICAL

Prikladnaia Matematika i Mekhanika, 1957, Vol 21, Nr 1, pp 27-34(U.S.S.R.)

Received 3/1957

Reviewed 5/1957

ABSTRACT

The method used here for the investigation of the asymptotic behavior of shock waves differs from the methods employed in the works carried out by L.D.LANDAU, G.B.WHITHAM, and L.I.SEDOV. By means of the here suggested method not only the dependence of the intensity of the shock wave on the distance up to the place of their occurrence, but also the dependence of such quantities can be determined as characterize the initial disturbance. Furthermore, this method permits the simple investigation of the asymptotic laws of damping of wave packets.

At first the shock waves are investigated at a great distance from the profile and from the rotation body. The plane and the axially-symmetric case are investigated simultaneously. Here the gas is supposed to flow along an infinite solid wall which, with the exception of an arc, is parallel to the x-axis, with supersonic velocity. A PRANDTL-MEYER flow with an inaccuracy of up to terms of the third order is realized behind the shock wave. The equations for the line of the shock wave are derived. The equation of the shock wave is written down in polar coordinates. Decrease of pressure on the shock wave is expressed by means of the wave resistance of the rotation body. Next, the general formulae for the determination of the intensity of the shock wave at the head and the tail of the body of rotation are derived. In conclusion, a further formula

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Damping of Shock Waves.

for the distance between the shock waves at the head and the tail is written down.

The second chapter deals with the shock waves in the case of a non-steady motion. The onedimensional, cylindrical and spherically-symmetric shock waves are here dealt with simultaneously. The author here determines the law of motion of the frontal shock wave. (For the rear shock wave everything is obtained in an analogous manner.)

In conclusion the asymptotic behavior of the wave packets is studied. At first the damping of a shock wave is investigated which propagates between two centered thinning waves in a plane or axially-symmetric flow which has become steady. In the most general case the wave packet which consists of a finite number of shock waves, splits up at a sufficiently great distance into a head- and tail wave which are separated by a condensating wave. Thus, only two waves can exist within great distances of bodies of any size. (6 illustrations)

ASSOCIATION	Not given
PRESENTED BY	
SUBMITTED	17. 7. 1956
AVAILABLE	Library of Congress

Card 2/2

LADYZHENSKIY, M. D. (Moscow)

"On Some Magnetogasdynamic Effects in Aerodynamics."

report presented at the First All-Union Congress on Theoretical and Applied Mechanics, Moscow, 27 Jan - 3 Feb 1960.

10.1230

31505

S/020/60/134/002/002/025
B104/B201

11.7430
AUTHOR:

Ladyzhenskiy, M. D.

TITLE:

Gas flows with high supersonic velocity

PERIODICAL: Doklady Akademii nauk SSSR, v. 134, no. 2, 1960, 296-299

TEXT: A study has been made of the flow equations for high supersonic velocities, which are simplified as a function of the flow parameter K . For $K \sim 1$ it is possible to use the equations of the perturbation theory of hypersonic flows for the case of flows around thin bodies. For $K \gg 1$ a solution of the Cauchy problem is obtained, that is of interest for the study of inner flows. In the first part of the paper, the author examines the steady flow of an ideal gas with a constant drag enthalpy. For planar ($\nu = 0$) and axially symmetric ($\nu = 1$) flows, the equation of continuity, the momentum equation, and the adiabatic equation are written as

$$\frac{1}{x-1} \frac{\partial \ln \eta}{\partial \tau} + \frac{\partial \theta}{\partial n} + \nu \frac{\sin \theta}{y} = 0, \quad \frac{\partial \theta}{\partial \tau} + \frac{\partial \eta}{\partial n} - \eta \frac{\partial \sigma}{\partial n} = 0, \quad \frac{\partial s}{\partial \tau} = 0, \quad (2).$$

The characteristic equations and the exact elementary solutions of (2) read

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Gas flows ...

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B104/B201

$$dy - \operatorname{tg}(\theta \pm \psi) dx = 0, \quad \operatorname{tg}^2 \psi = (\kappa - 1) \eta, \\ \pm d\theta + \frac{2}{\sqrt{\kappa - 1}} d\sqrt{\eta} + \nu \frac{\sin \theta \sin \psi}{\sin(\theta \pm \psi)} \frac{dy}{y} - \frac{\operatorname{tg} \psi}{\kappa - 1} d\sigma = 0, \quad (4),$$

$$y = x \operatorname{tg}(\theta \pm \psi) + Y(\theta), \quad 0 \mp \frac{2\sqrt{\eta}}{\sqrt{\kappa - 1}} = \operatorname{const}, \quad (5).$$

Here, ψ denotes the Mach angle, $Y(\theta)$ is an arbitrary function, and $\nu(\kappa - 1)(1 + \nu) = \operatorname{const}$ the source power (with $\sigma = \operatorname{const}$). For the purpose of evaluating the terms of equations (2), the characteristic quantities η and ψ are introduced for η and θ , respectively.

$$\frac{\Delta}{T\theta} : \frac{\theta}{T} = \frac{\Delta}{\theta^2} \sim \frac{1}{M^2 \theta^2} = \frac{1}{K^2}. \quad (9)$$

is obtained, where N and T are characteristic dimensions which, in the flow region concerned, refer to the directions along the flow lines and perpendicular thereto. For $K \sim 1$, the flow around a thin body is examined by a hypersonic flow. The equation holding in this case is shown to be:

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(as flows ...

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$$\frac{\partial}{\partial t} = [1 + O(\theta^2)] \left(\frac{\partial}{\partial x} + \theta \frac{\partial}{\partial y} \right), \quad \frac{\partial}{\partial n} = [1 + O(\theta^2)] \frac{\partial}{\partial y}. \quad (10).$$

The equations (2) can then be written in the form of equations for unsteady flows. For $K \gg 1$ the Cauchy problem is studied, and solution

$$\eta = \eta_0 \left(\frac{r_0}{r} \right)^{x-1} \left| \frac{r_0 \pm a}{r \pm a} \right|^{v(x-1)}, \quad \theta = \theta_0, \quad \sigma = \sigma_0, \quad (12)$$

is obtained. This solution fully fits the solution for hypersonic sources in the case of $v = 0$, and for $v = 1$ if $r \gg a$. This substantiates the correctness of the asymptotic solutions obtained by the author in a previous investigation (Tr. TsAGI, v. 779 (1960)) concerning the outflow of a gas jet into the vacuum. (12) is manifestly correct for a small v . In the final part the author examines the domains of definition of the solution. He proves the existence of infinite domains of definition of the solution, which is in connection with the parabolic degeneracy of the equations considered for the case in which M tends to infinity. A. A. Nikol'skiy is thanked for valuable advice. There are 3 figures and 6 references: 4 Soviet-bloc and 2 non-Soviet-bloc.

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Gas flows ...

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B104/B201

PRESENTED: April 27, 1960, by A. A. Dorodnitsyn, Academician

SUBMITTED: April 22, 1960

Card 4/4

LADYZHENSKIY, M. D.

Cand Phys-Math Sci - (diss) "Several problems in gas dynamics of hypersonic flows." Moscow, 1961. 12 pp; (Inst of Mechanics of the Academy of Sciences USSR); 130 copies; price not given; bibliography on pp 11-12 (21 entries); (KL, 6-61 sup, 194)

LADYZHENSKIY, M.D. (Moskva)

Hypersonic flow past slender blunt bodies. Izv. AN SSSR. Otd.
tekhn. nauk. Mekh. i mashinostr. no. 1:150-151 Jan-F '61.

(MIRA 14:2)

(Aerodynamics, Hypersonic)

34329

S/124/62/000/002/003/014
D234/D302

10.1200
AUTHOR: Ladyzhenskiy, M.D.

TITLE: Supersonic rule of areas

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 2, 1962, 22, abstract
2B125 (Inzhenernyy zh., 1., no. 1, 1961, 159-163)

TEXT: The author establishes the limits of applicability and gives an improvement of the supersonic rule of areas proposed by himself in a previous work (Izv. AN SSSR Otd. tekhn. n. Mekhan. i mashinostr., 1961, no. 1, 150-151 - RzhMekh. 1961. 11B131). To estimate the limits of applicability of the rule, the limitations formulated previously in a general form (the body must not pass the limits of the shock wave produced by the equivalent axially symmetrical body, the resistance of the blunt part must not exceed essentially the resistance of the remaining part of the body) are illustrated by calculating a specific example of the family of blunt elliptic cones. The improvement of the rule of areas is attained by considering the relations and estimating the orders of

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Supersonic rule of areas

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D254/D302

magnitude of the parameters in the entropy layer. A schematization of the phenomenon, more subtle than the initial assumption that the whole mass of gas is concentrated in the shock wave, reduces essentially the limits of applicability of the rule of areas. The requirement of equality of resistance of the blunt parts is replaced by the requirement that nose parts of the bodies at a certain distance from the front point should coincide (and consequently, be axially symmetrical). The body in this case must not pass outside the limits of the entropy layer instead of those of the shock wave as in the previous investigation. [Abstracter's note: Complete translation].

Card 2/2

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28973
S/179/61/000/003/016/016
E191/E435

AUTHOR:

Ladyzhenskii, M.D. (Moscow)

TITLE:

Generalization of the hypersonic law of areas

PERIODICAL:

Akademiya nauk SSSR. Izvestiya. Otdeleniye
tekhnicheskikh nauk. Mekhanika i mashinostroyeniye,
1961, No. 3, pp. 188-189

TEXT: A generalization of the hypersonic law of areas is given for the case when the body extends beyond the limits of the region bounded by the surface of the shock wave. The problem of flow is reduced to the equivalent problem of the non-stationary motion of a gas displaced by a piston. An analytical discussion leads to the following formulation of the generalized rule of areas in hypersonic flow around thin blunt bodies. For two blunt bodies with equal values of bluntness drag, which have equal parts emerging outside the limits of a circle (also called "Newton edges") and equal laws of variation of areas contained within the same circle, the laws of pressure variation and the motion of the shock waves in regions where the compressed layer does not adhere to the body are identical. The surface of the shock wave in these regions retains axial symmetry. It follows that the total drag values

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Generalization of the hypersonic ...

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of the two bodies are equal inasmuch as these drag forces are composed of three components, namely the forces acting on the Newton edges, the forces acting on bodies inside the circle, and the concentrated forces. Acknowledgments are expressed to M.N.Kogan. There are 2 figures and 4 references: 3 Soviet and 1 non-Soviet. The reference to an English language publication reads as follows: Hayes W.D., Newtonian flow theory in hypersonic aerodynamics, Proc. of the First Int. Congress in the Aeronaut. Sci. Pergamon Press, 1959.

SUBMITTED: January 18, 1961

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Card 2/2

LADYZHENSKIY, M.D. (Moskva)

Some integrals of transonic gas-flow equations. Inzh.zhur.2 no.1:
6-10 '62. (MIRA 15:3)

(Aerodynamics,Transonic)

BOGACHEVA, A.A. (Moskva); LADYZHENSKIY, M.D. (Moskva)

Hypersonic flow about slender blunt elliptic cones. Inzh.zhur.
2 no.3:14-20 '62. (MIRA 15:8)
(Aerodynamics, Hypersonic)

L 16/19-63 EPR/EPA(b)/EWP(k)/EWT(1)/EPF(n)-2/BDS/T-2 AFPTC/ASD/ESD-3/AFWL/
IJP(C)/SSD Ps-4/Pd-4/Pf-4/Pu-4 WM/EH S/124/63/000/004/005/064

AUTHOR: Ladyzhenskiy, M. D. 82

TITLE: Magnetohydrodynamic flow at low R sub m-values

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 4, 1963, 2, abstract 4312
(Sb. Vopr. magnitn. gidrodinamiki i dinamiki plazmy, v. 2, Riga, AN
LatvSSR, 1962, 215-220)

TEXT: Magnetohydrodynamic equations are written, describing in cylindrical coordinates (x, y) an axially-symmetric or plane steady flow of a nonviscous gas in the presence of a magnetic field. It is demonstrated that if the magnetic Reynolds number is small, and the assigned magnetic field H has a characteristic in the origin of coordinates of the form:

$$H = \frac{1}{\sqrt{x}} \phi\left(\frac{y}{x}\right)$$

(direction of x-axis coincides with direction of velocity of incident flow), the equations of motion then admit a class of self-reproducing solutions in which the pressure, density ρ and the velocity vector depend on $\zeta = x/y$. Specifically, a study is made of the problem of flow around a semi-infinite plate by a supersonic gas in a direction perpendicular to the plate's leading edge, in the presence,

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Magnetohydrodynamic flow at

within the plate, of surface currents directed perpendicularly to the flow plane and having the following distribution of current density $j = -A/\text{square root of } x$ (subscript after "x" illegible). The following is hypothesized: 1. the magnetic field being formed by such currents creates an abrupt density jump, originating from the plate's leading edge and 2. prior to the jump, the gas is not electrically conductive. In this case, the flow falls in the class of self-reproducing solutions and is described by three conventional differential equations relative to ρ and the velocity components u and v . A preliminary analysis of these equations is made. A solution is obtained describing the gas flow near a plate's surface. V. M. Kuptsov.

[Abstracter's note: Complete translation.]

Card 2/2

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36038
S/040/62/026/002/010/025
D299/D301

10.1200
24.4300
AUTHOR:

Ladyzhenskiy, M.D. (Moscow)

Analysis of hypersonic-flow equations and solution of
Cauchy's problem

TITLE:

PERIODICAL:

Prikladnaya matematika i mekhanika, v. 26, no. 2,
1962, 289 - 299

TEXT: The general hypersonic-flow equations are analyzed. It is noted that the solution to Cauchy's problem contains infinite domains of existence of the solution. The obtained approximate solutions to Cauchy's problem are compared with exact analytic and numerical solutions. After simplifying the iso-energetic flow equations, one obtains

$$\frac{1}{n-1} \frac{\partial \ln \eta}{\partial s} + \operatorname{div} \tau = 0, \quad \tau = 1$$

$$- \tau \frac{\partial \eta}{\partial s} + \operatorname{grad} \eta \equiv \operatorname{grad}_n \eta = \eta \operatorname{grad} \sigma - \frac{\partial \tau}{\partial s}$$

(1.5)

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APPROVED FOR RELEASE

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D299/D301

Analysis of hypersonic-flow ...

For plane- and axisymmetric flows, the properties of the solution to Eq. (1.5) are mainly determined by the parameter K which is the product of M_* by δ (which characterizes the range of variation of the velocity-vector inclination). With $K \gg 1$, the solution to Cauchy's problem is obtained: $K \gg 1$ involves the fulfilment of the conditions

$$|\theta(A) - \theta(B)| \gg \sqrt{\max \eta}, \quad \chi - \Psi > 0 \quad (\Psi = \arctg[(\kappa - 1)\eta]^{1/2}) \quad (2.1)$$

on the smooth arc AB (shown in a figure); $\max \eta$ denotes the maximum value of η on AB; θ is the angle of inclination of the velocity vector; χ is the sharp angle between the velocity vector and the tangent to AB; Ψ is the Mach angle. The solution to Cauchy's problem is

$$\eta = \eta_0 \left| \frac{r_0}{r} \right|^{\kappa-1} \left| \frac{r_0 + a}{r + a} \right|^{\chi(\kappa-1)} \quad \theta = \theta_0, \quad \sigma = \sigma_0. \quad (2.2)$$

This solution applies to both steady- and unsteady gas flow. It coincides with the asymptotic solution (obtained in an earlier investigation by the author and V.N. Guseva) to isentropic orifice-flow. ✓
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Analysis of hypersonic-flow ...

S/040/62/026/002/010/025
D299/D301

as follows: H.S. Tsien, Similarity laws of hypersonic flow. J. Math. Phys., 1946, v. 25, no. 3; W.D. Hayes. On hypersonic similitude. Quart. Appl. Math., 1947, v. 5, no. 1; A. Shapiro, The dynamics and thermodynamics of compressible fluid, I, Ronald Press, 1953.

SUBMITTED: September 26, 1961

Card 4/4

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41506
S/040/62/026/005/003/016
D234/D308

26.1410
AUTHORS:

Bogacheva, A. A. and Ladyzhevskiy, M. D. (Moscow)

TITLE:

A self-modelling solution of magnetohydrodynamic equations

PERIODICAL:

Prikladnaya matematika i mekhanika, v. 26, no. 5, 1962, 821-835

TEXT: The authors consider a plane stationary nonviscous supersonic flow around a wedge, assuming that there are surface currents on the edge whose intensity is inversely proportional to the square root of the distance from the wedge vertex, the conductivity is equal to zero in front of the shock wave and finite in the disturbed flow domain, the transition across the shock wave is described by the same relations as in absence of a magnetic field. Introducing an independent variable $\eta = y/x$ the authors obtain a system of three ordinary differential equations, which are investigated on the hodograph plane of the velocity. When the angle between the undisturbed flow direction and one of the lines forming the edge is smaller

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 ASD Paa-h/Pd-h/Pe-h WW
 ACCESSION NR: AP3004408
 EPA/EPA(b)/EWT(1)/EWT(m)/BDS/ES(v) AEDC/AFTTG/AFMDC/
 S/0286/63/000/004/0039/0040 70

AUTHOR: Ladyzhenskiy, M. D.

TITLE: Method for accelerating a gas flow to hypersonic velocities by means of a reaction nozzle. Class F, No. 153153

SOURCE: Byul. izobret. i tovarnykh znakov, no. 4, 1963, 39-40

TOPIC TAGS: hypersonic flow, boundary layer, jet nozzle

ABSTRACT: This Author's Certificate was issued for a method of accelerating a flow of gas to hypersonic velocities by means of a jet nozzle (see Fig. 1 of Enclosure). The parasitic effect of the boundary layer is eliminated by expanding the flow, which is achieved by an increase in the throat area, and high rarefaction of the gas at the nozzle outlet. Orig. art. has: 1 figure.

ASSOCIATION: none

SUBMITTED: 00

DATE ACQ: 20Aug63

ENCL: 01

SUB CODE: AI

NO REF SOV: 000

OTHER: 000

Card 1/2/

S/040/63/027/001/007/027
D251/D308

AUTHOR: Ladyzhenskiy, M.D. (Moscow)

TITLE: On magnetohydrodynamic hypersonic flow round a wedge

PERIODICAL: Prikladnaya matematika i mekhanika, v. 27, no. 1, 1963, 55-60

TEXT: The author considers the flow around a wedge of a gas which is ideal, perfect, and possesses finite conductivity in the region behind the shock wave. It is supposed that the magnetic field is inclined at an arbitrary angle to the surface about which the flow takes place, and that the velocity of flow is hypersonic. By establishing the equation of motion in dimensionless form and using boundary value methods and independent Crocco variables, a solution is obtained which gives a different value for the pressure from that calculated by Newton's formula in the author's earlier work (PMM, 1959, v. 23, no. 6) and allows for the possibility of cavitation in addition to rupture, whereas the earlier work allowed only for rupture. In the case where the magnetic field vector is inde-

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On magnetohydrodynamic ...

S/040/63/027/001/007/027
D251/D308

pendent of the arc length along the body, a detailed solution is given. There are 3 figures.

SUBMITTED: September 18, 1962

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LADYZHENSKIY, M.D. (Moskva)

Viscous hypersonic flow past slender bodies. Prikl. mat. i mekh.
27 no.5:765-778 S-O '63. (MIRA 16:10)

LADYZHENSKIY, M.D. (Moscow)

"Some problems of gasdynamics of three-dimensional flows".

report presented at the 2nd All-Union Congress on Theoretical and Applied Mechanics, Moscow, 29 Jan - 5 Feb 64.

ACCESSION NR: AP4019966

S/0020/64/154/006/1297/1298

AUTHOR: Galkin, V. S.; Lady*zhenskii, M. D.

TITLE: Computation of the boundary layer of a compressible fluid with slip boundary conditions

SOURCE: AN SSSR. Doklady*, v. 154, no. 6, 1964, 1297-1298

TOPIC TAGS: hydrodynamics, compressible fluid, slipping boundary condition, boundary layer, velocity discontinuity, slip, boundary condition, viscous flow

ABSTRACT: The authors investigated the effect of velocity discontinuities and temperature near the walls on the flow of a compressible fluid in the boundary layer on plane and axially-symmetrical bodies under conditions when the interference of the boundary layer with the nonviscous flow, the influence of the cross sectional curvature, and the like, can be considered independently from slipping. They have solved the problem by certain assumptions concerning the temperature at the boundary and by introducing the Dorodnitsy*n's variables. The

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ACCESSION NR: AP4019966

procedure is a generalization of the method used in the theory of non-compressible viscous flow in which the effect of velocity of slipping is taken into consideration by a shift of the y-coordinate which is proportional to the mean free path of gas molecules. Orig. art. has: no figures, 3 equations.

ASSOCIATION: none

SUBMITTED: 03Jul63

DATE ACQ: 23Mar64

ENCL: 00

SUB CODE: PH

NO REF SOV: 002

OTHER: 001

Card 2/2

I 10807465 EWT(1)/EVP(m)/ENG(y)/FCS(k)/EWA(1)
ESD(t)/AEDG(a)/AFTR(a)/ASD(2)-2/AFTR/ESD(58)
ACCESSION NR: AP4015964

Pd-4/Pa-5/11-4 AFWL/
RM/TM

8/0040/63/021/005/0765/0778

AUTHOR: Ladyzhenskii, M. D. (Moscow)

TITLE: Viscous hypersonic flow around thin bodies

SOURCE: Prikl. matem. i mekhan., v. 27, no. 5, 1983, 765-776

TOPIC TAGS: viscous flow, hypersonic flow, thin body, boundary layer, Navier Stokes equation, axisymmetric flow, boundary condition, nonviscous flow

ABSTRACT: The author considers hypersonic flow around a thin body by a viscous, heat-conductive gas. His assumption that the thickness of the boundary layer is comparable to or exceeds the thickness of the body entails moderate or strong interaction of the nonviscous flow with the boundary layer. The author sets up equations and formulates boundary conditions for three-dimensional flow around a tapered body. He does this by analyzing Navier-Stokes equations whose relative error Δ is the same as that of equations derived for the boundary layer in plane and axisymmetric flows. The essential characteristic of this problem is the necessity of calculating the relative pressure change across the region in which viscous forces predominate (despite the fact that viscous forces are of order of magnitude Δ). This contrasts with the plane and axisymmetric problems. Analogously to the division of plane

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ACCESSION NR: AP4015964

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axisymmetric hypersonic flow around a thin body into nonviscous flow and boundary layer; three-dimensional hypersonic flow is divided into viscous and nonviscous flow. To within the error, Δ , of the theory, the nonviscous flow will be axisymmetric, because the pressure depends essentially on the x coordinate alone in the region of viscous flow. It then follows that the ratio of lifting force in this case to that of a body in nonviscous flow is of the same order of magnitude as Δ (i.e., within the postulated limits of accuracy may be taken equal to 0). For the obtained system of three-dimensional equations, the author gives a self-similar solution which generalizes the known exact solution for the equations of an axisymmetric boundary layer with interaction. By obtaining an asymptotic solution for the equations of self-simulating motion near the exterior boundary of the region of viscous flow, he is able to prove the problem properly formulated. He studies flow around a tapered body as well as a body with slight blunting in considering the case of flow around a body of rotation at an angle of attack much smaller than the relative thickness of the body when linearization of the (relatively) axisymmetric flow is possible. "The author thanks V. S. Galkin, M. N. Kogan, V. S. Nikolayev, V. V. Struminskiy, and V. V. Bychev for their very valuable discussions." Orig. art. has: 67 formulas.

ASSOCIATION: none

Card 2/5

L 10807-65
ACCESSION FR: AP4015964

SUBMITTED: 01Apr63

SUB CODE: ME

NO REF SOV: 006

ENCL: 00

OTHER: 004

Card 3/3

L 8899-65 ENT(a)/ENT(1)/EPA(b)/ENT(m)/ENT(y)/ENT(k)/FCS(k)/EMA(h)/ENT(r)
 Pd-1/Pa-5/Pr-1 ASD(r)/AEDC(a)/SSD/ASD(p)-3/ESD(ga)/AFETR/ASD(d)/ESD(t)/AFWL/ESD/
 AFIC(a) WW

ACCESSION NR: AP4046267

S/0040/64/028/005/0835/0844

AUTHOR: Ladyzhenskiy, M. D. (Moscow)

TITLE: Three-dimensional hypersonic flow near thin wings B

SOURCE: Prikladnaya matematika i mekhanika, v. 28, no. 3, 1964, 835-844 76

TOPIC TAGS: hypersonic flow, three dimensional hypersonic flow, inviscid flow, viscous flow, entropy layer, boundary layer, strip theory

ABSTRACT: The problems of a hypersonic inviscid gas flow over thin wings with a blunted leading edge and of a viscous gas flow near wings with a sharp leading edge are considered. It is shown that the strip theory, which is used to calculate the flow outside the entropy and boundary layers, is not valid when the thickness of these layers is comparable to or exceeds wing thickness. In the case of viscous gas flow, the strip theory may be applicable to the whole flow at small values of the parameter $\epsilon = (\kappa - 1)/(\kappa + 1)$, where κ is the adiabatic exponent. An example is given for the case of inviscid flow over a thin

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ACCESSION NR: AP4046267

wing with a blunted leading edge for three different values of the swept angle (30° , 45° , and 60°) under the assumption of isentropic flow inside the entropy layer. A self-similar solution of the problem of viscous gas flow near a triangular plate with shaped leading edge is considered under the regime of a strong inviscid flow-boundary layer interaction. The effects of the leading edge bluntness and viscosity on a three-dimensional hypersonic flow near thin wings are evaluated when the entropy and boundary layer thicknesses are comparable to or exceeding thickness. Orig. art. has: 5 figures and 27 formulas.

ASSOCIATION: none

SUBMITTED: 02Apr64

ATD PRESS: 3109

ENCL: 00

SUB CODE: ME

NO REF SOV: 006

OTHER: 004

Card 2/2

1 32112-65 EWT(1)/EWP(m)/ENG(s)-2/ENG(v)/KPR/EPA(De)-2/FGS(k) Pd-1/Po-5/
 Pa-1/Pw-1 HW 8/0040/65/029/001/0099/0105
 ACCESSION NR: AP5006258

AUTHOR: Ladyzhenskiy, M. D. (Moscow)

TITLE: Hypersonic flow in nozzles ²³

SOURCE: Prikladnaya matematika i mekhanika, v. 29, no. 1, 1965, 99-105

TOPIC TAGS: hypersonic flow, nozzle flow, nozzle

ABSTRACT: To study the possibility of obtaining arbitrarily high Mach numbers by isentropic nozzle flow, an analysis was made of one-dimensional hypersonic flow of an ideal gas through a diverging nozzle whose parabolic surface is described by the equations:

$$y = cx^k(1 + \Delta(x)), \quad \lim_{x \rightarrow \infty} \Delta(x) = 0.$$

Isentropic equations for hypersonic flow developed previously by the author were used. As had been shown, hypersonic nozzle flow is characterized by the relationship $K = M_\infty \theta$, where M_∞ is the Mach number at a given station and θ is the sine of the angle between the velocity vector and the nozzle axis. It was found that $K \sim x^m$, where $m = k/n - 1$. The following cases were analyzed in detail: (1)

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ACCESSION NR: AP5006258

1 $> k > n$, (2) $k = n$, and (3) $n > k > 0$. For case (1) it was found that flow without shocks is impossible. In case (2) K remains constant as $x \rightarrow \infty$ and $\theta \rightarrow 0$. The equations reduce to non-steady-state flow equations similar to those obtained by the method of small perturbations. In case (3) $K \rightarrow 0$ as x increases. In this case hydraulic approximations may be used since the enthalpy, pressure, and density are constant in a given cross sectional plane. Possible flow configurations are plotted. Orig. art. has: 27 formulas and 6 figures. [pv]

ASSOCIATION: none

SUBMITTED: 24Apr64

ENCL: 00

SUB CODE: ME

NO REF SOV: 006

OTHER: 002

ATD PRESS: 3200

Card 2/2

15 May 65
LADZHENSKIY, M.D. [deceased] (Moskva)

Strong interaction between the boundary layer and an inviscid
flow on a triangular wing. Prikl. zat. i mekh. 29 no.4:635-
643 JI-Ag '65. (MIRA 18.9)

I 62-08-65 EWT(d)/EWT(1)/EWP(m)/EWT(m)/EWP, ZI-2/EWP(k)/FCS(k)/EWA(h)/EWA(1)

RR/EN

ACCESSION NR: AP5021298

UR/0040/65/029/004/0635/0643

AUTHOR: Ladyzhenskiy, M. D. (Moscow) (Deceased)

15 May 65

44

B

TITLE: On the strong boundary layer-viscous flow interaction on a delta wing

SOURCE: Prikladnaya matematika i mekhanika, v. 29, no. 4, 1965, 635-643

TOPIC TAGS: viscous flow, hypersonic flow, angle of attack, aerodynamics, boundary layer thickness, shock wave, slip flow, flow analysis, thin wing, delta wing

ABSTRACT: A hypersonic viscous gas flow over an infinitely thin delta wing at zero angle of attack is considered at $M_\infty = \infty$ and boundary layer-viscous flow interaction is investigated. The equation of a three-dimensional boundary layer in Cartesian coordinates is considered and a solution is sought for the region near the plane of wing symmetry. It was shown that the effective body thickness, which is dependent upon the displacement effect of the boundary layer, increases because the secondary flow streamlines, that is, those from the right and left leading edges, converge to the plane of wing symmetry. The thickening of the effective body near the plane of symmetry leads to the formation of a shock wave with a cross section in the form of a semicircle in the plane of $x = \text{constant}$, and to a rise in pressure over the value obtained for flows over a flat plate with slip. It was also shown that the

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ACCESSION NR: AP5021298

cross section of an effective body in a plane perpendicular to the velocity vector of a free stream approaches a semicircle when the Reynolds number tends to infinity. As an illustrative example, the results of a numerical calculation of the rise in pressure and the effective body thickness are given in graphs. Orig. art. has: 3 figures and 29 formulas. [AB]

ASSOCIATION: none

SUBMITTED: 10Oct64

ENCL: 00

SUB CODE: ME

NO REP SOV: ool

OTHER: 002

ATD PRESS: 40 72

Card 2/2

L 22708-66 EWT(d)/EWT(l)/EWP(m)/EWT(m)/EWP(w)/EWA(d)/T-2/EWP(k)/EWA(h)/ETC(m)-6/

ACC NR: AP6010855 SOURCE CODE: UR/0421/66/000/001/0142/0144

AUTHOR: Ladyzhenskiy, M. D. (Deceased; Moscow); Lipin, A. V. (Moscow)

ORG: none

TITLE: Aerodynamic properties of rectangular plates in rarefied, hypersonic gas flow

SOURCE: AN SSSR. Izvestiya. Mekhanika zhidkosti i gaza, no. 1, 1966, 142-144

TOPIC TAGS: hypersonic aerodynamics, hypersonic flow, viscous flow, free molecular flow, wind tunnel test, lift coefficient, drag coefficient, thin wing

ABSTRACT: An experimental investigation of aerodynamic properties of rectangular plates at an angle of attack in viscous hypersonic air flows was carried out with the purpose of determining the optimal dimensions of wings. These experiments were conducted in a low density wind tunnel on various rectangular plates having the same surface s , of various aspect ratios $\lambda = 0.1-9$, of relative thicknesses $\delta = d/\sqrt{s} = 0.025-0.16$ at a free-flow Mach number $M = 5.15$ and temperature $T_0 = 293^\circ K$ and $R_e = 2.3 \times 10^2$ under the assumption that the wing surface temperature is much lower than the air-flow stagnation temperature. The experiments included measurements of normal and tangential components of

L 22708-66

ACC NR: AP6010855

aerodynamic forces at different angles of attack. Comparisons of experimental values of the drag $C_x(\alpha)$ and lift $C_y(\alpha)$ coefficients obtained here with theoretical data based on the theory of free-molecular flow for total diffusion reflection, show that the theoretical values of the lift coefficient agree better with experiment than those of the drag coefficient. It was also established that the drag coefficient at $\alpha = 0$ decreases with λ , which is explained both by a decrease in the bluntness effect and by an increase in the effective Reynolds number. The dependence of K_m , the maximum value of the L/D ratio, on the aspect ratio λ and relative thickness δ is given in Fig. 1 and Fig. 2. The

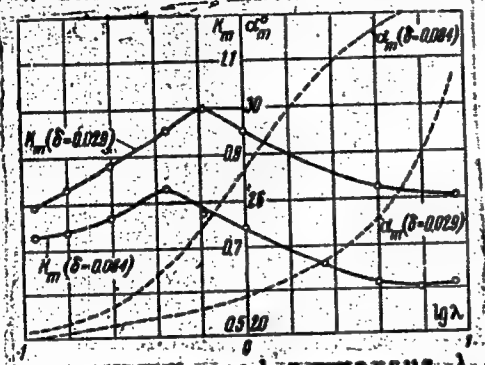


Fig. 1. K_m and α_m versus λ

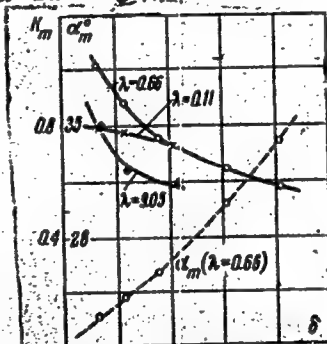


Fig. 2. K_m and α_m versus δ

Cord 2/3

L 22708-66

ACC NR: AP6010855

values of α_m , the angle of attack at which the maximum K_m is attained, are plotted in Fig. 1. An analysis of the curves shows that the values of K_m for a rectangular plate of finite surface and thickness have a maximum at a certain value of λ and that in case of viscous, hypersonic flows, wings with small aspect ratios ($\lambda < 1$) are more advantageous than wings with larger aspect ratio ($\lambda > 1$), in contrast to what happens at large Reynolds numbers. Orig. art. has: 5 figures.

[AB]

SUB CODE: 20/ SUBM DATE: 25Jul65/ ORIG REF: 001/ OTH REF: 001/
ATD PRESS: 4229

Card

3/3

BK

LADYZHENSKIY, M.M.

Prospects for using the "Zenit-2" electronic computer in the
petroleum and petrochemical industries. Mash. i nef't. obor.
no.2:30-35 '64. (MIRA 17:8)

9/123/61/000/020/031/035
A004/A101

AUTHOR: Ladyzhenskiy, M. M.

TITLE: Remote control of the welding current intensity

PERIODICAL: Referativnyy zhurnal, Mashinostroyeniye, no. 20, 1961, 41, abstract
201237 ("Sudostroyeniye", 1961, no. 6, 66)

TEXT: When using a multi-station welding generator, the author recommends a circuit (see Fig.) which makes it possible to remote-control the welding current. In the cited circuit the amperage is controlled by standard ballast rheostats of the PB-200 (RB-200) and PB-300 (RB-300) type, whose 4 cut-outs changing the resistance stages are replaced by KM-100 II (KM-100D) contactors. The contactor coils are supplied from the welding network via a potentiometric voltage divider consisting of resistors R_6 and R_7 of 50 ohm each. Remote control of the contactors is effected with special switches having 13 fixed positions. The switch is connected to the supply circuit of the contactor coils by a 5-core cable 25-35 m long and a ШП-28 (ShR-28) plug. There is 1 figure.
N. Alekseyev

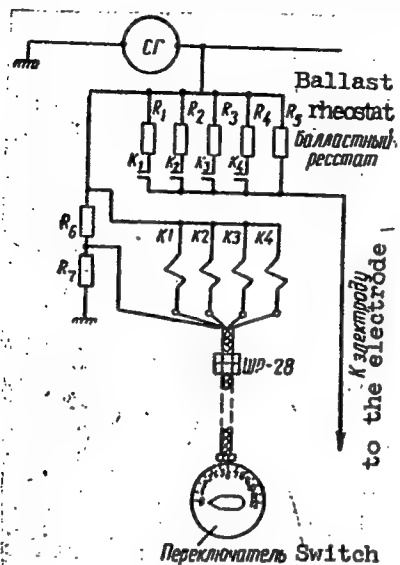
[Abstracter's note: Complete translation]

Card 1/2

Remote control of the welding current density

S/123/61/000/020/031/035
A004/A101

Figure:



Card 2/2

LADYZHENSKIY, M.M., inzh.

Prospects for the use of electronic controlling machines for the
automation of marine power plants. Sudostroenie 29 no.7:35-38
Jl '63. (MIRA 16:9)

(Electricity on ships) (Automation)

LADYZHENSKIY, M.M.; LYUBOMIRSKAYA, S.I.; TANKHILEVICH, V.A.;
TOMASHEVSKAYA, I.A.; TSIRKEL', M.L.; GRANATMAN, V.V.,
red.

[Use of TK-3B, TKh-4B, and TKh-5B cold-cathode thyratrons
in pulse circuits] Opyt primeneniia tiratronov s kholod-
nym katodom tipov TK-3B, TKh-4B, TKh-5B v impul'snykh
skhemakh. Leningrad, 1964. 22 p. (MIRA 17:11)

RAYCHENKO, I. I. (Leningrad)

Study and comparative analysis of transistor switches with
different control principles. Avtomatika no.4:89-96 '65.
(MIRA 18:9)

PORFIR'YEV, V.B. [Porfir'iev, V.B.], akademik; GRINBERG, Y.V.
[Hrinberh, I.V.]; LADYZHENSKIY, M.R. [Ladyzhens'kyl, M.R.];
LINETSKIY, V.P. [Linets'kyl, V.P.]; GALABUTSKAYA, K.A.
[Halabuts'ka, K.A.]; TKACHUK, L.G. [Tkachuk, L.H.];
SVARICHEVSKIY, L.V. [Svarychevs'kyl, L.V.]; RIPUN, M.B.
[Rypun, M.B.]; GABINET, M.P. [Habinet, M.P.]; CHEKHOVICH,
N.Ya. [Chekhovych, N.IA.], red.; MATVIICHUK, O.O., tekhn.
red.

[Carpathian menilite shales] Menilitovi slantsi Karpat. Kyiv,
Vyd-vo Akad. nauk URSR, 1963. 204 p. (MIRA 16:6)

1. Akademiya nauk Ukr. SSR (for Porfir'yev). Institut geologii
goryuchikh iskopayemykh AN Ukr.SSR (for all except Chekhovich,
Matviichuk).

(Carpathian Mountains—Oil shales)

LADYZHENSKIY, N.R. [Ladyzhens'kyi, M.R.]; PLOTNIKOV, A.M.; GORDIYEVICH, V.A.
[Gordiyevich, V.A.]

Sulfur on the Dzhan-Tepe mud volcano (Kerch Peninsula). Dop. AN
URSR no.5:640-643 '65. (MIRA 18:5)

GTRSPL, NO. 45

Vyalov, O.S., Ladyzhinski, N.R. and Tkachuk, L.G. (Institute of the Geology of Useful
Fossils, Ukrainian S.S.R. Academy of Sciences and the Lvov Polytechnical Institute), The
tufaceous level in the menillite range of the eastern Carpathians, 137-9

Akademiya Nauk, S.S.S.R., Doklady, Vol. 79, no. 1

LADYZHENSKIY, N.R.

POBFIR'YEV, Vladimir Borisovich; GRINBERG, Iona Vol'kovich; LADYZHENSKIY,
Nikolay Romanovich; GALABUTSKAYA, Yekaterina Antonovna; LIHETSALI,
Viktor Filippovich, SVARICHEVSKIY, Igudomir Vladimirovich;
LAZARENKO, Ye.K., otvetstvennyy redaktor; LISENBART, D.K., redaktor
izdatel'stva; RAKHLINA, N.P., tekhnicheskiy redaktor

[Menilite shale, a source for industrial building materials]
Menilitovye slantsy - syr'e dlia promyshlennosti stroitel'nykh
materialov. Kiev, Izd-vo Akademii nauk USSR, 1956. 37 p. (MIRA 9:7)

1. Ghlen-korrespondent AN USSR (for Lazarenko)
(Shale)

PORFIR'YEV, V.B., otvetstvennyy redaktor; LADYZHENSKIY, N.R., kandidat
geologo-mineralogicheskikh nauk, redaktor; ~~LAZARENKO, Ye.K.~~, redaktor;
GURZHIY, D.V., kandidat geologo-mineralogicheskikh nauk, redaktor;
ZAVIRYUKHINA, V.N., redaktor; ZHUKOVSKIY, A.D., tekhnicheskii
redaktor

[Papers on the problem of the origin and migration of petroleum]
Materialy diskussii po probleme proiskhozhdeniya i migratsii nefiti.
Kiev, 1956. 366 p. (MLRA 10:3)

1. Akademiya nauk URSR, Kiyev. L'vivskiy filial. Instytut geologii
korysnykh kopalyn. 2. Chlen-korrespondent Akademii nauk USSR (for
Profir'yev, Lazarenko)
(Petroleum geology)

LADYZHENSKIY, N.R.

PORFIR'YEV, V.B., akademik, red.; BROD, I.O., prof., red.; ~~LADYZHENSKIY, N.R., red.~~; YERSHOV, P.R., vedushchiy red.; POLOSINA, A.S., tekhn.red.

[Problem of the migration of oil and the formation of oil and gas accumulations; materials of the Lvov discussion, May 8-12, 1957]
Problema migratsii nefti i formirovaniya neftianyykh i gazovykh skoplenii; materialy L'vovskoi diskussii 8-12 maia 1957 g. Pod red. V.B.Porfir'eva i I.O.Broda. Moskva, Gos.nauchno-tekhn.izd-vo neft.i gorno-toplivnoi lit-ry, 1959. (MIRA 12:4)

1. Akademiya nauk USSR, Kiyev. L'vovskiy filial. Institut geologii poleznykh iskopayemykh. 2. Akademiya nauk USSR, predsedatel' Orgkomiteta L'vovskoy diskussii 8-12 maya 1957 g. (for Porfir'yev). 3. Kafedra geologii i geokhimii goryuchikh iskopayemykh Moskovskogo universiteta im. Lomonosova, Moskva, i Institut nefti AN SSSR (for Brod).

(Petroleum geology)

LADYZHENSKIY, N.R. [Ladyzhens'kyi, M.R.]

Development of views on the geology of gas fields in western
region of the Ukrainian S.S.R. Pratsi Inst. geol. kor. kop.
AN URSR 1:101-107 '59. (MIRA 14:6)
(Ukraine—Gas, Natural—Geology)

LADYZHENSKIY, Nikolay Romanovich, prof.; ANTIPOV, Viktor Ivanovich; POR-
FIR'YEV, V.B., akademik, red.; YUNGANS, S.M., vodushchiy red.;
VORONOVA, V.V., tekhn. red.

[Geology, and gas and oil potentials of the Soviet cis-Carpathian region] Geologicheskoe stroenie i gazonaftenosnost' Sovetskogo Predkarpat'ia. Moskva, Gos. nauchno-tekhn. izd-vo neft. i gorno-toplivnoi lit-ry, 1961. 265 p. (MIRA 14:10)

1. Akademiya nauk USSR (for Porfir'yev)
(Carpathian Mountain region—Petroleum geology)
(Carpathian Mountain region—Gas, Natural—Geology)

LADYZHENSKIY, N.R.

Time of the formation of oil fields in the Carpathians.
Geol.sbor. [Lvov] no.7/8:79-88 '61. (MIRA 14:12)

1. Institut geologii poleznykh iskopayemykh AN USSR, L'vov.
(Carpathian Mountain region--Petroleum geology)
(Geological time)

ANTIPOV, Viktor Ivanovich; LADY ZHENSKIY, N.R., doktor geol.-miner.
nauk, otv. red.; MEL'NIK, A.F., red.

[Seismotectonics of the western provinces in the Ukraine]
Seismotektonika zapadnykh oblastei Ukrainy. Kiev, Naukova
dumka, 1965. 54 p. (MIRA 18:4)

VARNOVITSKIY, I.N.; LADYZHENSKIY, P.B.

Present status and future development of welding techniques in
East Germany. Biul.tekh.-ekon.inform. no.8:76-78 '60.
(MIRA 13:9)

(Germany, East--Welding)

VORNOVITSKIY, I.N.; LADYZHINSKIY, P.B.

Improvement of welding techniques in East Germany, Czechoslovakia,
and Poland. Biul.tekh.-ekon.inform. no.1:93-96 '61. (MIRA 14:2)
(Germany, East—Welding) (Czechoslovakia—Welding)
(Poland—Welding)

ACCESSION NR: AP4043189

S/0070/64/009/004/0516/0520

AUTHORS: Fedulov, S. A.; Lady*zhenskiy, P. B.; Venevtsev, Yu. N.

TITLE: Investigation of the system $\text{BiFeO}_3\text{-LaAlO}_3$

SOURCE: Kristallografiya, v. 9, no. 4, 1964, 516-520

TOPIC TAGS: bismuth inorganic compound, lanthanum compound, ferroelectric property, perovskite structure, solid solution, dielectric constant

ABSTRACT: Both investigated compounds have a perovskite structure and were expected to form solid solutions. It was also assumed that addition of LaAlO_3 to BiFeO_3 would lead to a decrease of the conductivity which would facilitate the study of the temperature dependence of the dielectric constant in a wide range of temperatures. It was assumed that the results of these measurements would further confirm the presence of ferroelectric properties in bismuth ferrite. The in-

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ACCESSION NR: AP4043189

Investigation of the system was also aimed at studying the effect of various factors on the magnetic properties of similar compounds, and to determine regions in which they possess special dielectric and magnetic properties. The starting materials were Bi_2O_3 , Fe_2O_3 , Al_2O_3 (analytical purity), and La_2O_3 (technical purity). The x-ray analysis was carried out with $\text{CuK}\alpha$ and $\text{CoK}\alpha$ radiation. The lattice parameters were determined to within 0.0015 \AA , the volume to within 0.07 \AA^3 , and the angle to within $2'$. The magnetic measurements were carried out by a method described in Kristallografiya v. 8, no. 4, p. 610, 1963. X-ray analysis of samples with intermediate compositions showed that one-phase perovskite solid solutions occurred only up to 37.5 mole % LaAlO_3 . Samples with 25--35 mole % LaAlO_3 exhibit the clear maxima of the dielectric constant typical of ferroelectrics. With increasing LaAlO_3 content the maxima shift towards lower temperatures. The temperature dependence of the specific magnetization for samples of the homogeneous region was obtained at $H = 7600 \text{ Oe}$.

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ACCESSION NR: AP4043189

All solid solutions were found to be antiferromagnetic with weak ferromagnetism. For samples with 35 mole % LaAlO_3 the specific spontaneous magnetization reaches 0.15. The Curie temperature of BiFeO_3 is estimated by extrapolation to be about 850°C . The data make it possible to construct a part of the phase diagram of the system BiFeO_3 -- LaAlO_3 on the side of BiFeO_3 (Encl. 01). The decrease of the ferroelectric Curie temperature with increasing LaAlO_3 content is due, in the opinion of the authors, to the considerably weaker electron polarizability of the Li^{3+} ion compared with that of Bi^{3+} . Most interesting is the rather strong increase of the Neel temperature on the introduction of LaAlO_3 . This is due mainly to the somewhat smaller lattice constant of LaAlO_3 . "The authors thank Prof. G. S. Zhdanov and Yu. E. Roginskaya for valuable advice and remarks." Orig. art. has: 7 figures.

Card 3/5

ACCESSION NR: AP4043189

ASSOCIATION: VNII khimicheskikh reaktivov i osobo chisty*kh vesh-
chestv Fiziko-khimicheskiy institut im. L. Ya. Karpova (All-Union
Institute of Chemical Reagents and Ultrapure Materials, Physico-
chemical Institute)

SUBMITTED: 25Sep63

ENCL: 01

SUB CODE: SS

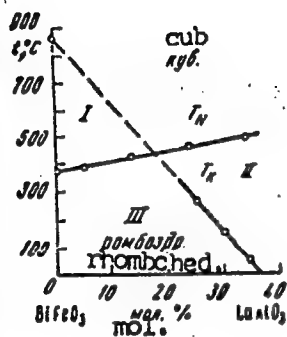
NR REF SOV: 014

OTHER: 002

Cord 4/5

ACCESSION NR: AP4043189

ENCLOSURE: 01



Part of the phase diagram of the BiFeO_3 - LaAlO_3 system on the BiFeO_3 side.

T_K - ferroelectric Curie temperature, T_N - antiferromagnetic Neel temperature
 I - ferroelectric region
 II - region of weak ferromagnetism
 III - region with combined properties

Card 5/5

LADYZHENSKIY, P. M.

Air Conditioning

Effective system of automatic regulation. Tekst. prom. 12, No. 9, 1952.

Monthly List of Russian Accessions, Library of Congress, December 1952. UNCLASSIFIED

LADYZHENSKIY, R.M.; NIKOLAYEVA, N.G., redaktor; MEDVEDEVA, L.A., tekhnicheskoy redaktor

[Air conditioning] Konditsionirovanie vozdukh. Moskva, Pishche-promizdat, 1952. 275 p.
(Air conditioning) (MIRA 10:1)

LADYZHENSKIY, R.M., kand. tekhn. nauk.

Investigating the movement of a spheroid bubble in a liquid medium.
Trudy ITIKHP 5:105-115 '54. (MIRA 11:3)

(Bubbles)

LADYZHENSKIY, R. M.

(3)
Investigation of rise of air bubbles in water at high Reynolds numbers. R. M. Ladyzhenskii. *Zhur. Priklad. Khim.* 27, 22-32(1954). — The rate of rise of smaller bubbles up to 3 cc., was previously investigated by Goroletskaia (C.A. 43, 4082a) and by Spilnov, et al. (C.A. 46, 4320a). L. investigates larger bubbles up to 20 cc. and larger. The correlation of exptl. and calcd. values is in closer agreement as the bubble vol. and Reynolds no. increase to 20 cc. and 12800, resp. Bubble deformation in its movement is analyzed in detail. I. Benicovitz

LADYZHENSKIY, R.M.

GALOCHKIN, Nikolay Aleksandrovich; LADYZHENSKIY, R.M., dotsent, retsensent;
GOL'DSHTEYN, I.D., redaktor; DASHKOVA, Z.P., redaktor; KOLESHNIKOVA,
A.P., tekhnicheskii redaktor

[Ventilation of pulp and paper factories] Ventiliatsiia predpriatii
tselluloznoy promyshlennosti. Moskva, Goslesbumizdat, 1955.
222 p. (MLRA 8:11)

(Ventilation) (Wood-using industries)

LYADZHENSKIY, R. M.

Investigation of the shape of a gas bubble rising in a stationary fluid. M. Lyadzenkiy. *Zhur. Priklad. Khim.* 29, 103-104 (1956); cf. C.A. 50, 5780b. Math. analysis of capillary, hydrodynamic, and gravitational forces affecting the shape of a rising bubble in a stationary medium indicate that the effect of the first 2 is negligible. The method used for the detn. of this shape is outlined. For bubbles of air (0.15 and 4 cc.) rising in H₂O the exptl. data, over a wide range of Reynolds nos., are expressed by:

$$\frac{r}{R} = 1 - \frac{A_1}{A_2} \frac{z}{l} \text{ and } \frac{r}{R} = 1 - \frac{A_1}{A_2} \frac{z}{l} \frac{1}{1 + \frac{A_1}{A_2} \frac{z}{l}}$$
 where r is the rad. of the bubble, l the meridional length, z the distance from the upper curvature to any horizontal plane passing through the spheroid, and R is the radius of this plane.
 X. B.

LADYZHENSKIY, Roman Markovich; VEYNBERG, B.S., spetsredaktor; AKIMOVA, L.D.,
red.; KISINA, Ye.I., tekhn.red.

[Air conditioning] Konditsionirovanie vozdukha. Izd. 2-oe, perer.
i dop. Moskva, Pishchepromizdat, 1957. 441 p. (MIRA 11:5)
(Air conditioning)

LADYZHANSKIY, R. M.

"Calculation of Injector Air-coolers."

Report submitted for the Conference on Heat and Mass Transfer,
Minsk, BSSR, June 1961.

LADY ZHENSKIY, Roman Markovich; GOGOLIN, A.A., rešsenzents; NIKOLAYEVA,
N.G., red.; EL'KINA, E.M., tekhn. red.

[Air conditioning] Konditsionirovanie vozdukha. 3. izd., perer.
i dop. Moskva, Gostorgizdat, 1962. 350 p. (MIRA 15:11)
(Air conditioning)

BUNAKOV, A.G., land.tekhn. nauk (Khar'kov); VANDOLOVSKIY, A.G., inzh.
(Khar'kov); LADYZHENSKIY, V.F., inzh. (Khar'kov); LOZANSKIY,
V.R., kand. tekhn. nauk (Khar'kov)

Concrete pipes for irrigation systems. Gidr. i mel. 16 no.10:
20-24 0 '64. (MIRA 17:12)

LADYZHENSKIY, V. P.

IVANOV, V.I., inzh.; KORSHUN, G.F., inzh.; POGREBENSKIY, G.M., inzh.;
BEKKER, D.Z., inzh.; LADYZHENSKIY, V.P., inzh.

Machine used for simultaneous laying and plastering of brick blocks.
Rats. i sobr. predl. v stroi. no.2:28-33 '57. (MIRA 11:1)

1, Omskstroy Ministerstva stroitel'stva predpriyatiy neftyanoy
promyshlennosti.

(Building blocks) (Building machinery)

VANDOLOVSKIY, O. [Vandolovs'kiy, O.], inzh.; LADYZHENSKIY, V. [Ladyzhens'kiy, V.], inzh.; UGINCHUS, D. [Uhinchus, D.], inzh.

Conference on problems of the use of carbonate aggregates. Bud.
mat.i konstr. no.5:62-64 S-O '62. (MIRA 15:11)
(Rocks, Carbonate) (Aggregates (Building materials)--Congresses)

GIRBASOVA, Ye.I., red.; LADZHEVSKIY, I.G., red.; KULIYEV, M.K., red.;
MIGAY, L.S., vedushchiy red.; MUKHINA, E.A., tekhn.red.

[Technical instruction charts of the complete cycle of the
underground repair of wells] Instruktivno-tekhnologicheskie
karty polnogo tsikla podzemnogo remonta skvashin. Moskva, Gos.
nauchno-tekhn.izd-vo neft. i gorno-toplivnoi lit-ry, 1960.
223 p.
(MIRA 13:12)

1. Moscow. Nauchno-issledovatel'skiy institut truda. Tsentral'-
noye byuro promyshlennykh normativov po trudu.
(Oil wells--Equipment and supplies)

LADYZHENSKIY, Yefim Borisovich; REUT, N.I., red.; SARAYEV, B.A.,
tekh. red.

[Fitting marine shaftings by the photography of a ray of
light] Montazh sudovykh valoprovodov s pomoshch'iu foto-
grafirovaniia svetovogo luch. Moskva, Izd-vo "Morskoi
transport," 1961. 84 p. (MIRA 15:2)
(Shipfitting) (Shafting)

POLONSKIY, M.S.; ZHURAVIN, M.A.; IADYZHENSKIY, Ye.B.; PINSKER, B.I.;
ZUBOV, V.O.; SNESTERIKOV, A.A.; YAKUN', F.V.; KRYNITSA, M.N.;
AREF'YEV, B.A.; YEVZIKOV, L.I., starshiy stroitel' sudov;
PAVLENKO, I.F.; YEKOVLEV, B.M., inzh.; MARKOV, A.P., inzh.

Readers' response to the article by engineer M.A. Daikhes
entitled "Method of mounting the main engines with minor
deformations of the foundation frame and the cranshaft".
Sudostroenie 30 no.10:57-66 O '64.

(MIRA 17:12)

1. Gruppovoy inzh.-mekhanik SSKh parokhodstva "Kaspar" (for Zubov).
2. Inzh.-inspektor Registra SSSR (for Yakun').
3. Glavnyy inzh.-inspektor inspektsii Registra SSSR Baltiyskogo basseyna (for Aref'-yev).
4. Starshiy mekhanik teplokhoda "Tadzhikistan" (for Pavlenko).

KULAKHMET'YEVA, M.G., kandmed.nauk; LADYZHINSKAYA, M.A., ordinator

Treatment of eye burns by subconjunctival injections of penicillin
combined with the patient's own blood. Oft.zhur. 14 no.6:334-337
'59. (MIRA 13:4)

1. Iz kafedry glaznykh bolezney (zav. - dots. A.S. Vays) Kazanskogo
meditsinskogo instituta.
(EYE--WOUNDS AND INJURIES) (BLOOD AS FOOD OR MEDICINE)
(PENICILLIN)

S/133/61/000/011/006/010
A054/A127

AUTHORS: Babakov, A. A., Candidate of Technical Sciences, Ladyzhinskiv, B. S.,
Engineer

TITLE: Corrosion resistance of electric-welded 1X18H9T (1Kh18N9T) steel
tubes

PERIODICAL: Stal', no. 11, 1961, 1026 - 1029

TEXT: Tests were carried out to study the corrosion resistance of stainless
steel tubes 10 - 76 mm in diameter; with a wall thickness of 1 - 2 mm produced
at the Moscow trubnyy zavod (Moscow Tube Plant) by continuous argon-arc welding
at a rate of 1.5 - 2.0 m/min. The tests in which E. Ye. Tsypina, Engineer, I. I.
Ivanova, Engineer, L. P. Basova, Laboratory Assistant, T. S. Sadykova, Laboratory
Assistant, L. N. Belogurova, Laboratory Assistant and V. I. Shashina, Laboratory
Assistant participated, were aimed at investigating the resistance of the welding
seam to corrosion in general and to intergranular corrosion compared with the
base metal. The test tubes (16 x 2 and 25 x 2 mm in size) contained 0.11% C,
0.93% Si, 0.89% Mn, 18.9% Cr, 9.1% N, 0.68% Ti and 0.10% C, 1.08% Si, 1.32% Mn,
18.5% Cr, 9.7% N and 0.50% Ti respectively. The heat treatment of the 1Kh18N9T

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Corrosion resistance of...

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steel was carried out under the following conditions: a) heating alternatively to 1,050, 1,100 and 1,200°C, holding for 2, 6 and 20 minutes at each temperature; quenching in water; b) heating alternatively to 850 and 900°C with 60 and 120 minutes holding, to 950°C with 30 and 60 minutes holding; air-cooling (stabilizing anneal); c) water-hardening of the specimens at 1,050°C with subsequent stabilizing anneal at 850 - 870°C (double heat treatment). Part of the tubes was subjected to a provoking tempering (heating to 650°C, holding time 120 minutes, air-cooling) in the as delivered condition, while part of the tubes was subjected to provoking tempering after the heat treatment as mentioned above. The test tubes were boiled in aggressive media according to the following scheme: in 10-% solution of formic acid for 96 hours; in 10-% solution of acetic acid for 144 hours; in 55-% solution of nitric acid for 144 hours; in a solution of vitriol (110 g) and sulfuric acid (55 ml) in 1 liter of water (A-method, ГОСТ 6032-58 [ГОСТ 6032-58]) for 48 hours; in a solution of vitriol (160 g) and 100 ml sulfuric acid in 1 liter of water containing copper chips for 24 hours. It was found that the tubes (16 x 2 mm) in the as delivered condition without additional heat treatment were sufficiently corrosion-resistant to formic acid, acetic acid and nitric acid. Additional heat treatment in the form of stabilizing annealing and

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Corrosion resistance of...

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quenching, without subsequent provoking tempering improved their corrosion resistance in nitric acid. The best results as to general corrosion resistance were obtained for tubes after hardening at 1,050 - 1,200°C. Provoking tempering (at 650°C) decreased the corrosion resistance of tubes in nitric acid not only for specimens in the as delivered condition, but also for those which had undergone additional heat treatment. Therefore the additional heat treatment of the tubes in the critical temperature range during operation is not necessary. However, stabilizing annealing of specimens subjected to provoking tempering prior to the tests had a positive effect on the corrosion resistance. The resistance to intergranular corrosion was studied by metallographic methods. Stabilizing anneal increased the resistance to intergranular corrosion. When operating in nitric acid of average concentration and high temperature, it was found advisable to use stainless steels with a lower carbon content and a more stable solid solution. The problem, whether additional heat treatment should be applied or not has to be decided under consideration of the composition of aggressive media involved in the production, the processes to which the tubes are subjected in the following stages at the plants producing chemical equipment and the operation conditions of the tubes in aggressive media. There are 7 figures.

ASSOCIATION: TsNIICM and Moscow trubnyy zavod (Moscow Tube Plant)

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LADYZHINSKIY, M.M.

The "Zenit-2" electronic centralized-control machine. Biul.
tekh.-ekon. inform. Gos. nauch.-issl. inst. nauch. i tekhn.
inform. 17 no.4:37-39 Ap '64. (MIRA 17:6)

L 41157-66 ENT(1)

ACC NRR AP6015386

(N)

SOURCE CODE: UR/0410/65/000/004/0089/0096

AUTHOR: Ladyzhenskiy, M. M. (Leningrad)

ORG: none

TITLE: Study and comparative analysis of transistorized gates employing different control principles

52
B

SOURCE: Avtometriya, no. 4, 1965, 89-96

TOPIC TAGS: transistorized circuit, hf transistor, germanium transistor, circuit design, silicon diode, silicon transistor, germanium diode, P-15A germanium transistor, P-406 germanium transistor, MP-106 silicon diode, P-29A germanium diode, P-30A germanium diode, MP-106 silicon transistor, MP-102 silicon transistor

ABSTRACT: A classification of noncompensated type transistor gates is proposed. A comparison is made of bipolar control in the case of noncompensated series-loaded keys using transistors of various types. Graphs are given illustrating typical relationships of residual voltage to control voltage and control current for hf germanium transistors type P-15A, hf germanium transistors type P-406, and silicon diodes type MP-106. Tabulated results are presented of residual voltage tests of a number of transistors in the B region under different control principle and at a temperature of +20C for samplings of from 100 to 200 units. Similar information is given for residual voltage stability with environmental temperature and control

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UDC: 621.316.5:681.2.08

L 11157-66

ACC NR: AP6015386

current variations. Recommendations are given regarding the selection of transistor type and control current for the design of operationally reliable gates. The conclusions show that for transistor gates it is preferable that the current source and not the voltage source be used for gate control, since current control provides a higher degree of residual voltage stability with environmental temperature and modulating voltage fluctuations, and a smaller mean value of residual voltage and mean-square deviation. The If germanium diodes type P-15A, P-29A, and P-30 were found to be the most promising Soviet-made transistors for low-voltage switching in the +20—70C temperature range. Because of their considerable parameter spread and residual voltage instability, MP-106 and MP-102 silicon transistors can be recommended for the switching of low voltages only in circuits with an upper temperature limit of +75—130C, where the germanium devices cannot be employed. Orig. art. has: 3 formulas, 3 tables, and 4 figures.

SUB CODE: 09/ SUBM DATE: 26Sep64/ ORIG REF: 006/ OTH REF: 001

Card 2/2 hs

LADYZHINSKIY, N.R. [Ladyzhyns'kyi, M.R.]; GURZHIY, D.V. [Hurzhii, D.V.]

Ophiolitic rocks of Mount Petrosk in the Magura zone. Dop. AN
URSR no. 6:789-791 '64. (MIRA 17:9)

1. Institut geologii i geokhimii goryuchikh iskopayemykh.
Predstavleno akademikom AN UkrSSR V.B.Porfir'yevym [Porfyr'iev,
V.B.]

S/0181/64/006/002/0475/0478

ACCESSION NO: AP4013507

AUTHORS: Fedulov, S. A.; Ladyzhinskiy, P. B.; Pyatigorskaya, L. I.; Venevtsev, Yu. N.

TITLE: Complete phase diagram of the system $\text{PbTiO}_3\text{-BiFeO}_3$

SOURCE: Fizika tverdogo tela, v. 6, no. 2, 1964, 475-478

TOPIC TAGS: phase diagram, PbTiO_3 sub 3, BiFeO_3 sub 3, piezoelectric, phase transition, Curie point, morphotropic phase transition, polarization, ferroelectric, ferromagnetic, Neel temperature, conductivity

ABSTRACT: Using x-ray investigations and electrical and magnetic measurements, the authors have constructed a complete phase diagram of the system $\text{PbTiO}_3\text{-BiFeO}_3$. This diagram is shown in Fig. 1 on the Enclosure. It is seen that in the region of the morphotropic phase transition the Curie point is very high (on the order of 700C), and it therefore seems suitable (in order to obtain high-temperature piezoelectric material) to introduce other material into the system to decrease the conductivity and to improve the conditions of polarization. The authors suggest, from this point of view, studies of the three-component systems $\text{PbTiO}_3\text{-BiFeO}_3\text{-PbZrO}_3$ and $\text{PbTiO}_3\text{-BiFeO}_3\text{-LaAlO}_3$. "The authors consider it their duty to express

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ACCESSION NO: AP4013507

thanks to Yu. Ye. Roginskaya for her aid in the work." Orig. art. has: 5 figures.

ASSOCIATION: Vsesoyuznyy nauchno-issledovatel'skiy institut khimicheskikh reaktivov i osobo chistykh khimicheskikh veshchestv, Moscow (All-Union Scientific Research Institute of Chemical Reagents and Extra Pure Chemical Substances)

SUBMITTED: 12Aug62

DATE ACQ: 03Mar64

ENCL: 01

SUB CODE: PH

NO REF SOV: 009

OTHER: 001

Card 2/12.

VENEVTSSEV, Yu. N.; ZHDANOV, G. S.; ROGINSKAYA, Yu. Ye.; FEDULOV, S. A.;
IVANOVA, V. V.; CHKALOVA, V. V.; VISKOV, A. S.; KAPYSHEV, A. G.;
BONDARENKO, V. S.; LADYZHINSKIY, P. B.

Some solid solutions on the basis of the ferroelectric-
antiferromagnetic BiFeO_3 . Izv. AN SSSR. Ser. fiz. 28 no. 4:
683-690 Ap '64. (MIRA 17:5)

L 49952-65 EEC(b)-2/EPA(s)-2/EEC(k)-2/EWA(c)/EWT(1)/EWT(m)/EWP(b)/T/EWP(t) Pl-4/
 PL-7 IJP(c) GG/JD/JG UR/0070/65/010 002/0268/0270 53
 46
 8

ACCESSION NR: AP5008477

AUTHOR: Fedulov, S. A.; Shapiro, Z. I.; Ladyzhinskiy, P. B.

TITLE: Application of the Czochralski technique in growing LiNbO_3 , LiTaO_3 , and NaNbO_3 single crystals

SOURCE: Kristallografiya, v. 10, no. 2, 1965, 268-270

TOPIC TAGS: crystal, piezoelectric crystal, potassium compound, niobate, tantalum compound, alkali metal, ferroelectricity, crystallization

ABSTRACT: Previously reported Soviet sources have described research on growing large piezoelectric single crystals of potassium niobate and potassium tantalate using the technique of spontaneous or oriented (seed) crystallization from a fluxed melt.

In the most recent Soviet publication, the subject has been enlarged to include all niobates and tantalates of alkaline metals, using the Czochralski technique to grow single crystals of these compounds. However, the emphasis was put on metaniobate and metatantalate of lithium, the properties of which are relatively unknown as compared to those of corresponding

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ACCESSION NR: AP5008477

sodium and potassium compounds. The work was motivated by the previously detected ferroelectric property in ceramic samples of LiTaO_3 and some preliminary indications that LiNbO_3 may be pyroelectric (the "frozen ferroelectric" of Megaw).

Such materials in single crystalline form are known to display an electro-optic effect which makes their application very promising in optical shutters or modulators at uhf (at least 10^4 Mc/sec). The stated purpose of the work was to produce large flawless crystals by the Czochralski technique, which was considered more advantageous than the previously used techniques.

Crystal growth experiments were carried out in universal VTsP crystallization apparatus which was designed by the Special Design Office of the Institute of Crystallography, Academy of Sciences USSR. The powdered charge was induction heated in platinum or platinum-rhodium crucibles to a temperature $50-70^\circ\text{C}$ above the melting point of the corresponding compound. The crystals were grown in air at pulling speeds of $11-25$ mm/hr. Crystal orientation was obtained by self-nucleation of the melt on a platinum wire acting as a seed. All crystals were annealed at $1050-1300^\circ\text{C}$.

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ACCESSION NR: AP5008477

The single crystals of the following materials were obtained by using the Czochralski technique: LiNbO_3 (mp = 1170°C), maximum size of 10×50 — 60 mm, transparent or yellowish (after annealing), oriented in the $[0001]$ direction; LiTaO_3 (mp = 1560°C), intensely yellow-green, dimensions unspecified, prepared with some difficulty because of a relatively high melting point; and NaNbO_3 (mp = 1350°C), maximum size of 10×50 mm, grown with extreme difficulty because of strain which produces cracks. The strain is due to five phase transitions between 640°C and room temperature.

Attempts to grow NaTaO_3 , KTaO_3 , and KNbO_3 single crystals by the Czochralski technique failed because of the high melting point (over 1650°C) of NaTaO_3 or incongruent melting of the potassium compounds. The most suitable growth techniques for large single crystals of the potassium compounds are believed to be either crystallization from fluxed melts, with seeding as described by C. E. Miller⁴ or hydrothermal growth. The NaTaO_3 single crystals might be grown by the Czochralski technique but in crucibles made of more refractory metals or alloys.

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ACCESSION NR: AP5008477

Only samples of rubidium and cesium niobates and tantalates were prepared by the usual ceramic technology to establish their crystal structure. The x-ray study of the samples indicated a structure different from perovskite for these compounds. This finding seems to contradict a previous Soviet source which attributed perovskite structure to RbNbO_3 and RbTaO_3 .

The Karpov Physicochemical Institute and the All-Union Scientific Research Institute of Chemical Reagents and High-purity Substances were given as the authors' affiliation.

In a post-scriptum, the authors pointed out recent American sources, which reported a large electro-optic effect in single crystals of $\text{K}(\text{Ta}, \text{Nb})\text{O}_3$ solid solutions, and in LiNbO_3 and LiTaO_3 crystals grown by the Czochralski technique.⁶

COMMENT: The technique used by the authors to produce single crystals of LiNbO_3 and LiTaO_3 closely resembles the one more recently described by A. A. Ballman. However, the crystals produced by the Soviet authors, according to the descriptions given, seem to be somewhat inferior in respect to color and dimensions. The authors of the Soviet article erroneously

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ACCESSION NR: AP5008477

quoted American sources as having reported an electro-optic effect in LiTaO_3 single crystals. In fact, both American sources report no significant effect at direct current or 21 Mc/sec in the material produced by the Czochralski technique. Orig. ayt. has 3 figures and 1 table.

¹RSB, v. 1, no. 1, 1965, 30-32.

²Shapiro, Z. I., S. A. Fedulov, and Yu. N. Venetsev. Curie point of the ferroelectric LiTaO_3 . Fizika tverdogo tela, v. 6, no. 1, 1964, 316-317.

³Vaynshteyn, B. K. Present-day problems of crystallography. IN: Akademiya nauk SSSR. Vestnik, no. 6, 1963, 31-38.

⁴Journal of Applied Physics, v. 29, no. 2, 1958, 233-234.

⁵Gensic, J. E., S. K. Kurtz, L. G. Van Uitert, and S. H. Wemple. Applied Physics Letters, v. 4, no. 8, 1964, 141-143.

⁶Peterson, G. E., A. A. Ballman, P. V. Lenzo, and P. M. Bridenbaugh. Applied Physics Letters, v. 5, no. 3, 1964, 62-64.

⁷Ballman, A. A. Journal of the American Ceramic Society, v. 48, no. 2, 1965, 112-113

Card 5/6

L 49052-65

ACCESSION NR: AP5008477

ASSOCIATION: Fiziko-khimicheskiy institut im. Zarpova (Physico-Chemical Institute)

SUBMITTED: 08Jun64

ENCL: 00

SUB CODE: SS, IC

NO REF SOV: 008

OTHER: 008

FSB, v. 1, no. 6

Card 6/6 76

7

CA

Corrosion of metals under the influence of some gasoline and kerosenes. N. J. Laduzhnikova. Repts. *Govt. Petroleum Research Inst. (Moscow) 1932*, 139-43.

Strips of various metals were immersed in gasoline from Ural contg. 0.458% S. It reacted considerably with Pb and to a smaller degree with Cu, brass and Fe, while the distillate did not attack brass or iron. A kerosene of the same origin which had 1.684% S attacked all 3 metals to a much greater extent, while the distillate which contained 1.925% S attacked Cu and brass more vigorously and Fe much less than the refined product. Cracked gasoline from Baku attacked, after contacting for 7 months, the following metals arranged in decreasing order of attack: Pb, Fe, Cu and brass. The attack was not so severe if the samples were kept in the dark. This phenomenon is explained by the presence of unsatd. compounds in the cracked gasoline which are oxidized in the presence of metals, the latter acting as catalysts. This gasoline also showed a higher acidity after the expt. Baku kerosene had a corrosive action on the following metals arranged in decreasing order: Pb, brass, Cu, Fe and Al; the latter was not attacked during the 21 months of the expts. This phenomenon was accompanied by an increase in the I no., the aniline pt. and the acidity. Kerosene said. with water attacked the metals in a more severe manner than dry kerosene.

A. A. Bachtelgik

ASD-3LA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND COLUMNS										3RD AND 4TH COLUMNS									
PROCESSING AND PROPERTY INDEX																			
<p>227</p> <p>*Corrosion of Metals under the Influence of Some Petrols and Kerosenes. N. I. Laduzhnikova (<i>Rep. Govt. Petroleum Res. Inst. (Moscow), 1932, 139-143;</i> <i>C. Abz., 1934, 22, 449</i>).—[In Russian.] Strips of various metals were im- mersed in petrol from the Urals containing 0.458% sulphur. It reacted con- siderably with lead and to a smaller degree with copper, brass, and iron, whilst its distillate did not attack brass or iron. A kerosene of the same origin which had 1.684% sulphur attacked all 3 metals to a much greater extent, whilst the distillate which contained 1.925% sulphur attacked copper and brass more vigorously and iron much less than the refined product. Cracked petrol from Baku attacked, after contact for 7 months, the following metals arranged in decreasing order of attack: lead, iron, copper, and brass. The attack was not so severe if the samples were kept in the dark. This phenomenon is explained by the presence of unsaturated compounds in the cracked petrols which are oxidized in the presence of metals, the latter acting as catalysts. This petrol also showed a higher acidity after the experiment. Baku kerosene had a corrosive action on the following metals, arranged in decreasing order of attack: lead, brass, copper, iron, and aluminium; the latter was not attacked during the 21 months' period of the experiments. This phenomenon was ac- companied by an increase in the iodine number, the aniline point, and the acidity. Kerosene saturated with water attacked the metals in a more severe manner than dry kerosene.—S. G.</p>																			
ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION										6-2 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 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